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Amano et al.

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(54) **VEHICLE LAMP**

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(73) Assignee: **Koito Manufacturing Co., Ltd.**, Tokyo (JP)

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(51) **Int. Cl.**[7] **F21V 5/00**
(52) **U.S. Cl.** **362/520**; 362/518; 362/328; 362/297
(58) **Field of Search** 362/31, 307, 326–328, 362/518, 297, 520; 359/726

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(57) **ABSTRACT**

Light from an LED light source, which is placed to be directed toward the front of a lamp, is incident on a translucent member, and the light that is transmitted through the translucent member is reflected by a reflector toward the front of the lamp. An internal reflection portion that internally reflects light which is incident on the translucent member at a small angle with respect to an optical axis of the LED light source, in a direction which is substantially perpendicular to the optical axis, and a refraction portion that refracts light which is incident at a large angle with respect to the optical axis, in a direction which is substantially perpendicular to the optical axis, are formed on the surface of the translucent member. The LED emitted light can be caused to be incident on a reflective surface of the reflector in the form of substantially parallel beams which are directed in a direction that is substantially perpendicular to the optical axis. The LED emitted light can be caused to be incident on the range extending even to the peripheral edge of the reflective surface, without increasing the depth of the reflector. The reflection due to the reflector can be easily controlled.

12 Claims, 16 Drawing Sheets

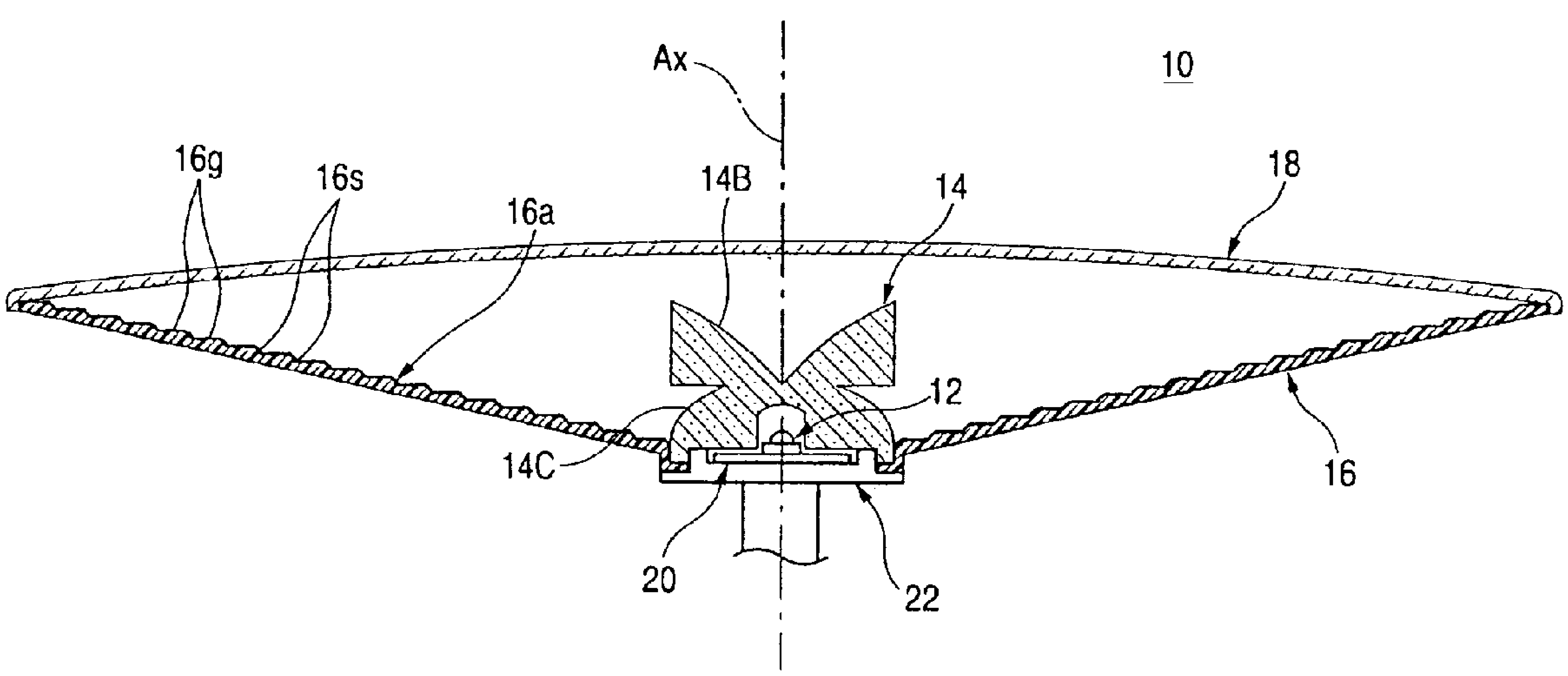

FIG. 1

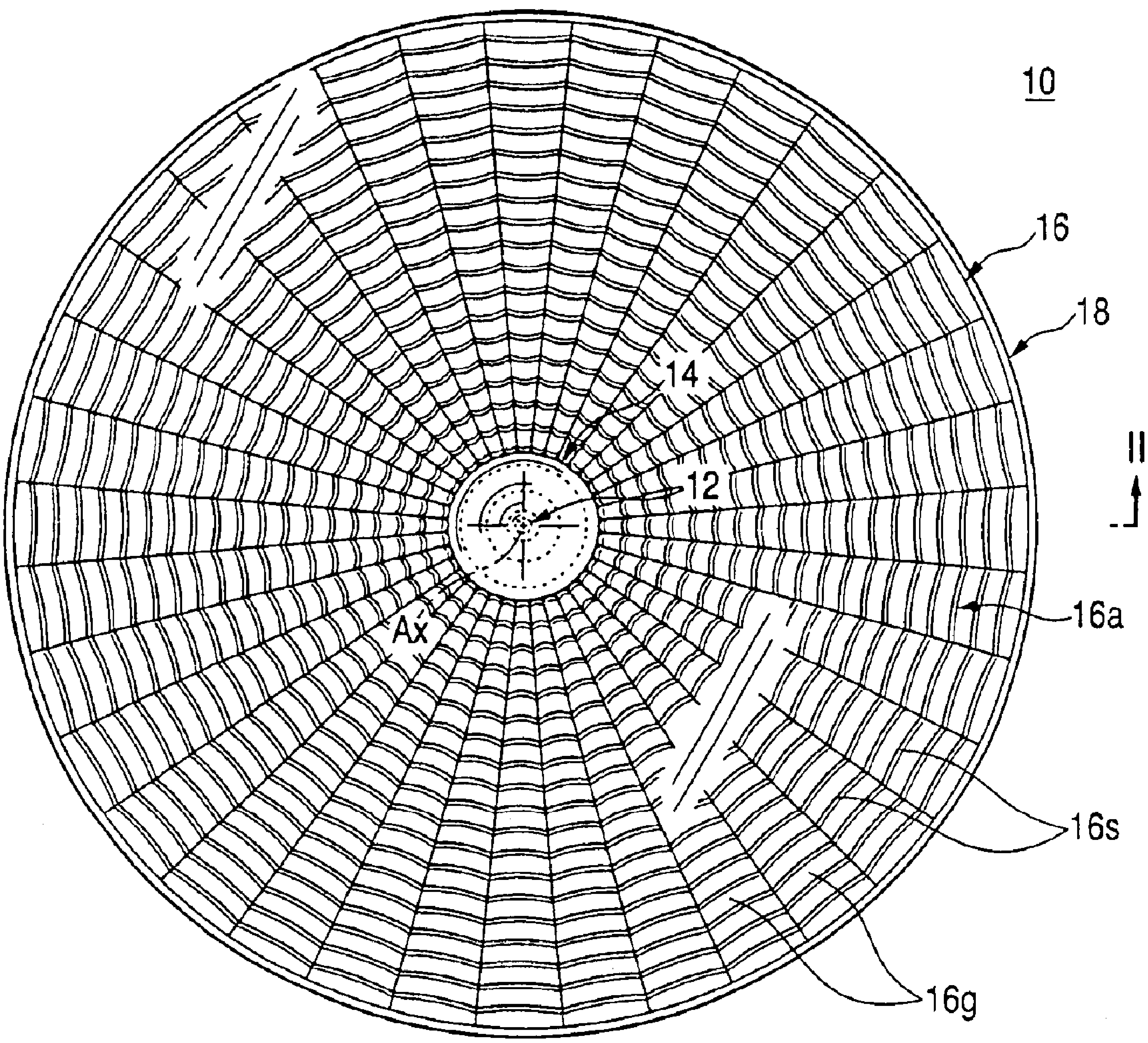

FIG. 2

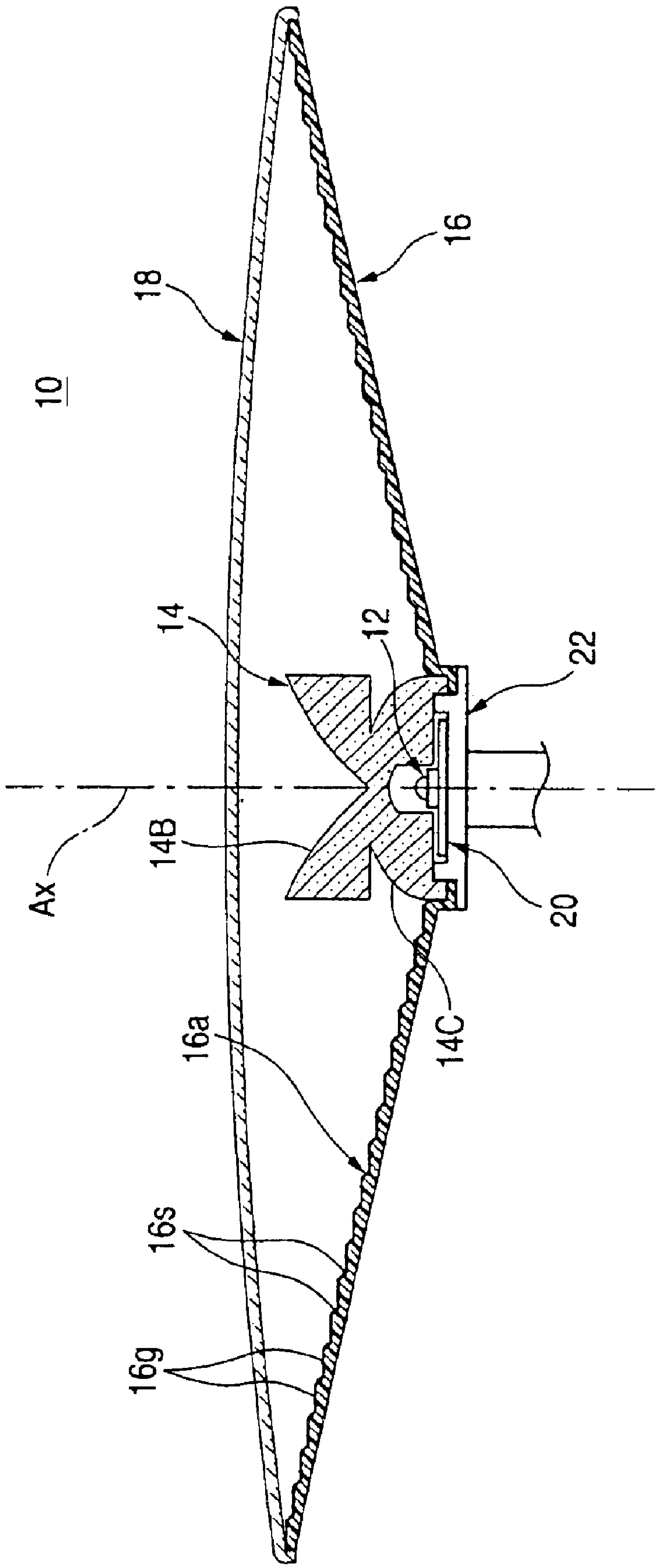

FIG. 3

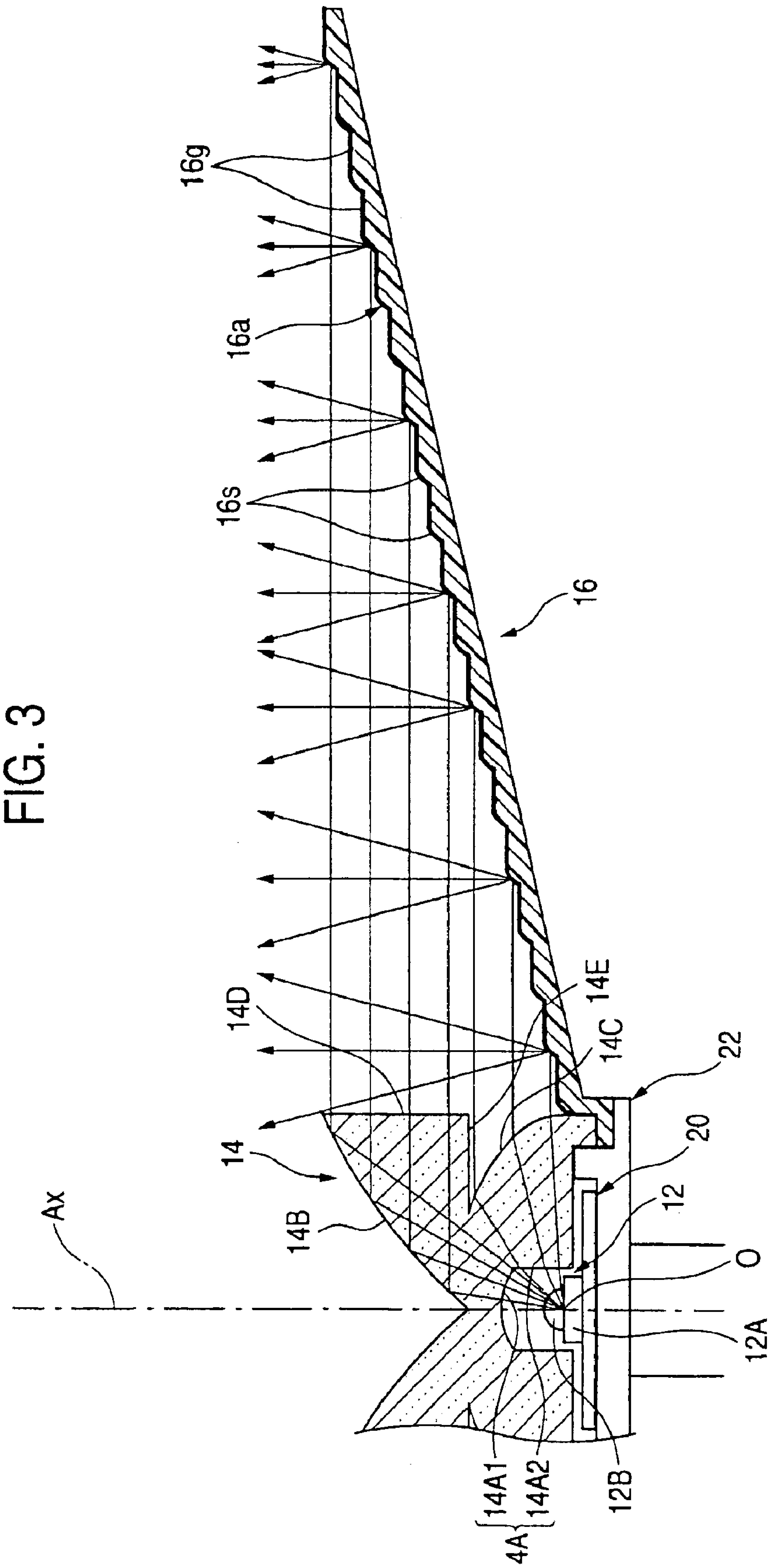
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FIG. 4

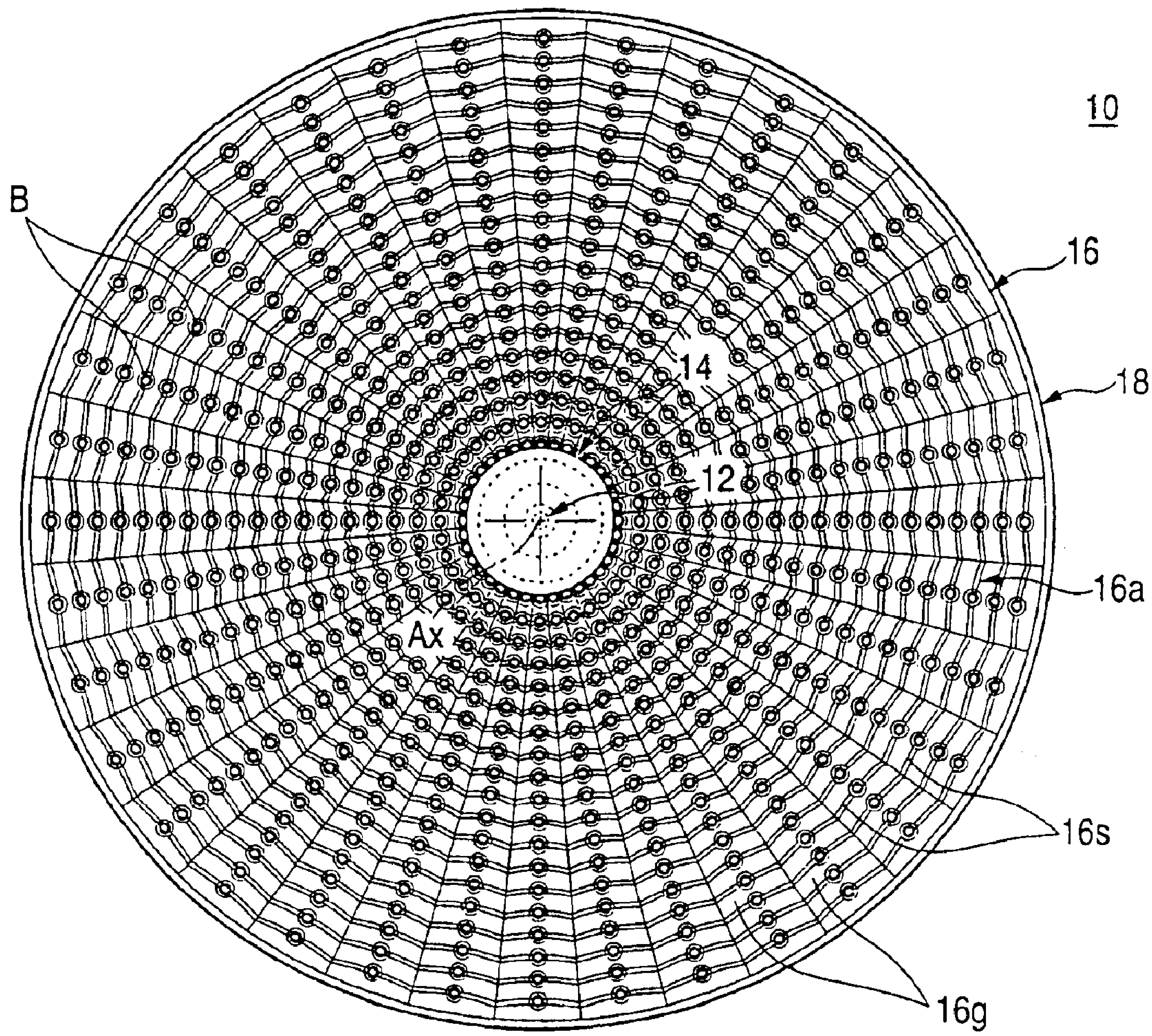

FIG. 5

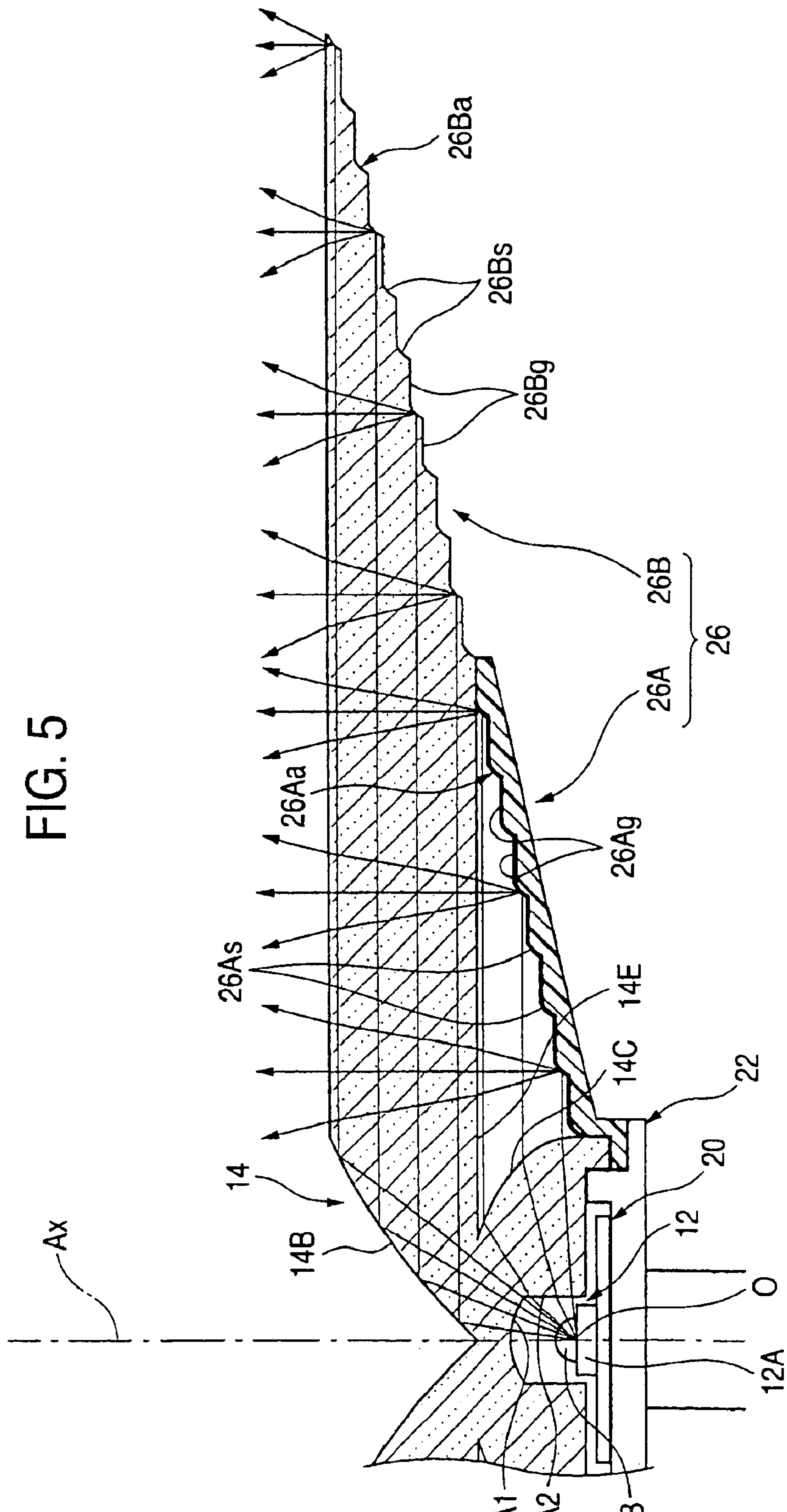
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FIG. 6

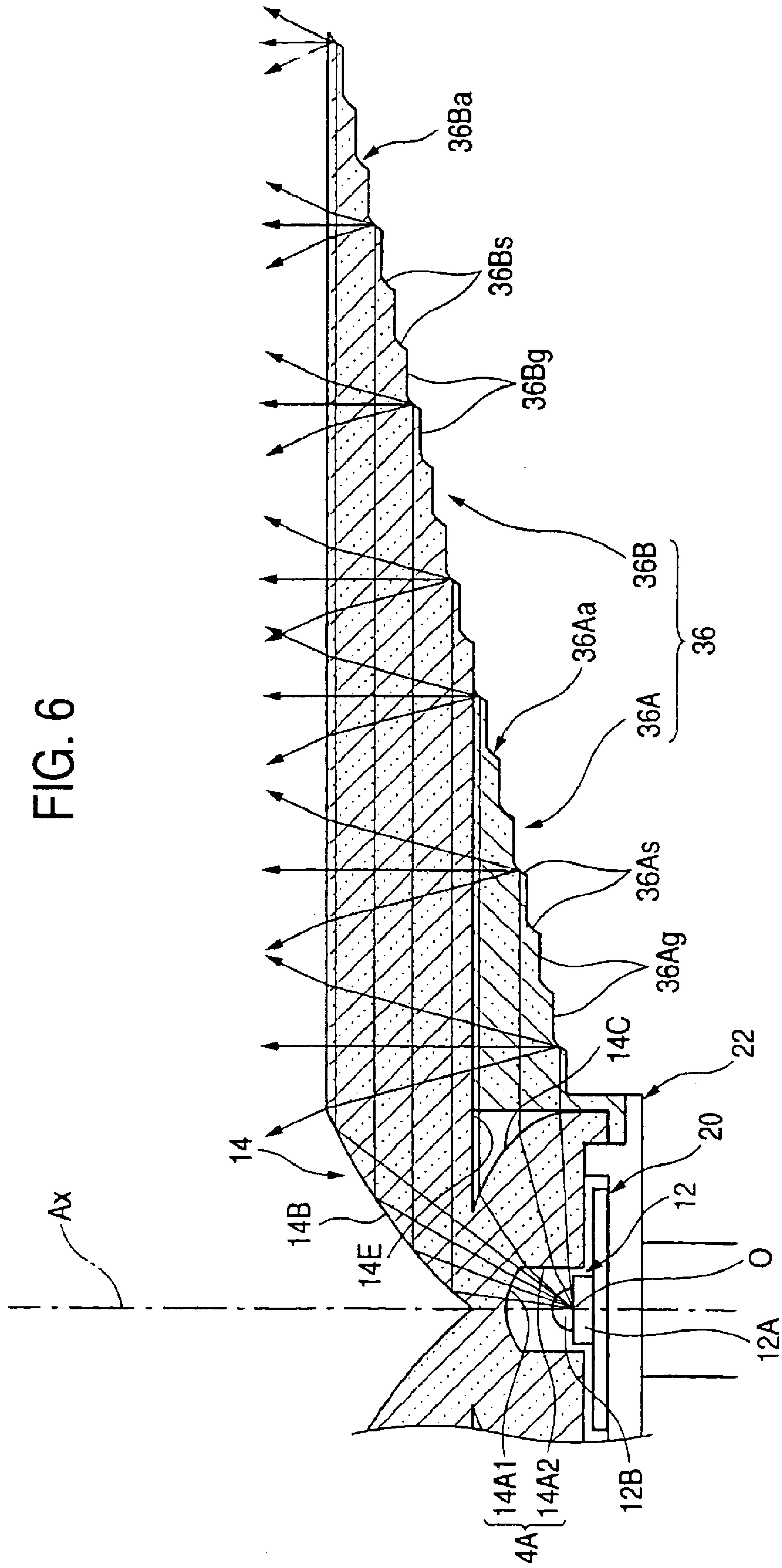
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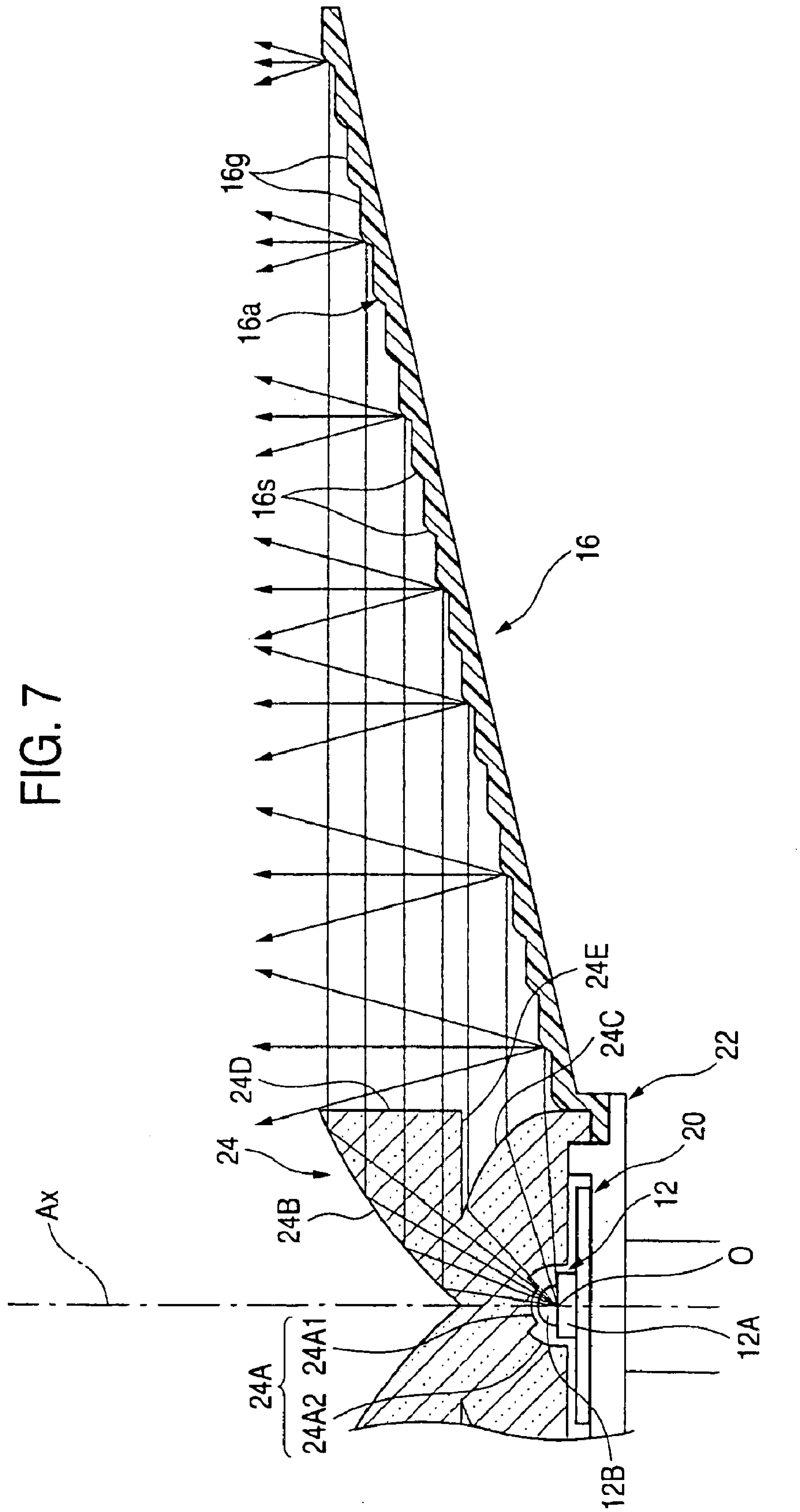
FIG. 7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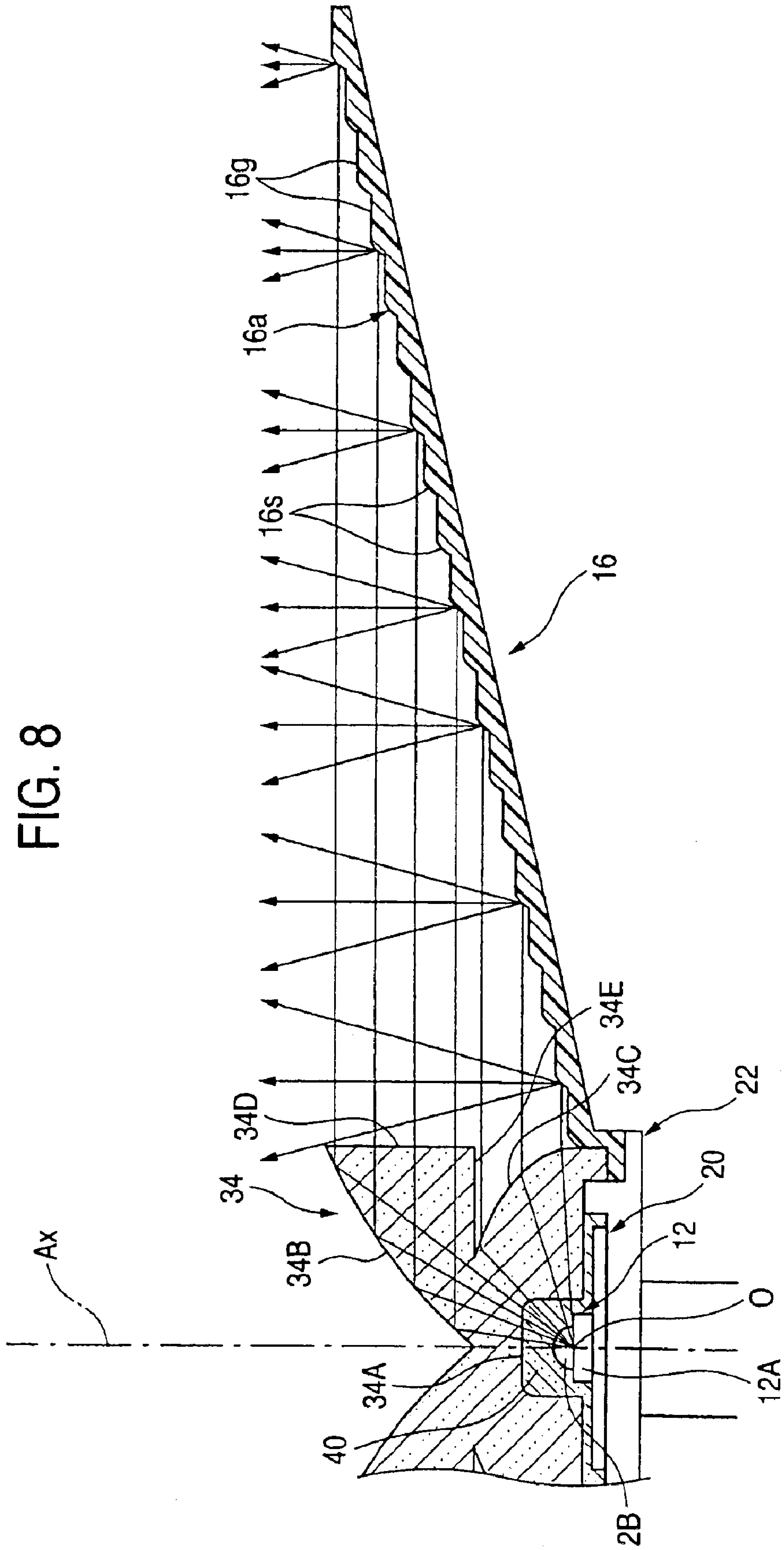


FIG. 8

FIG. 9

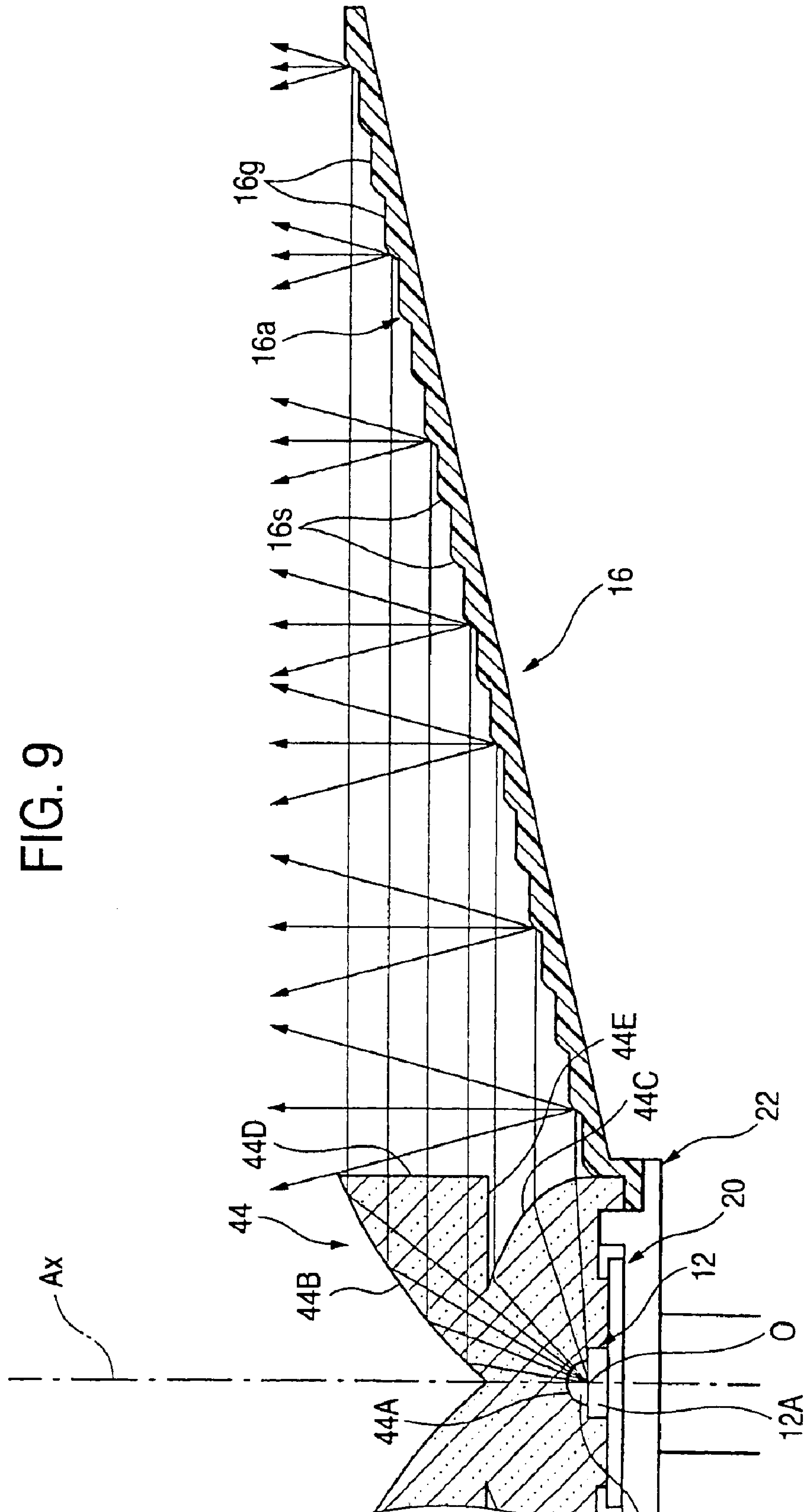


FIG. 10

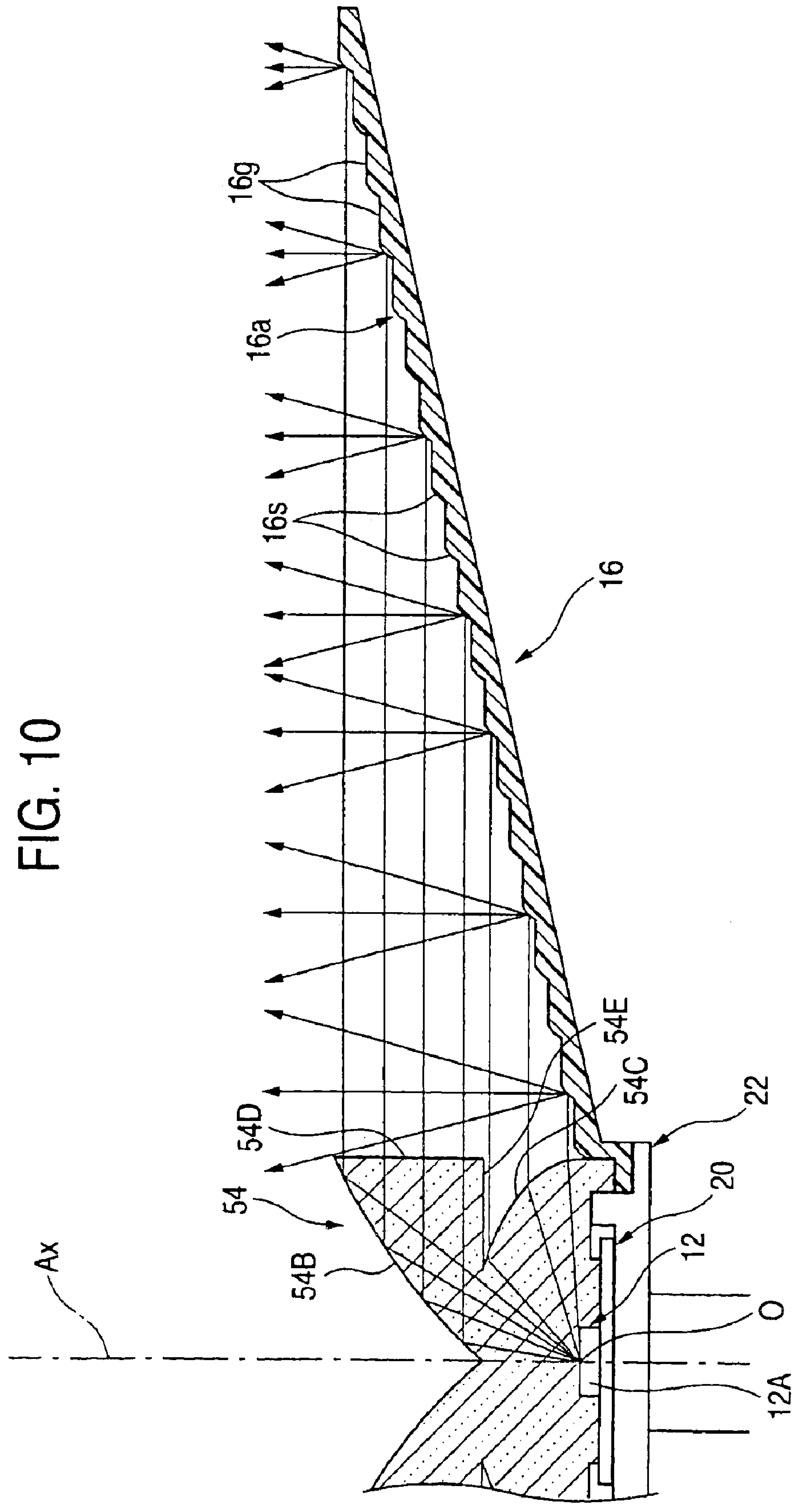


FIG. 11

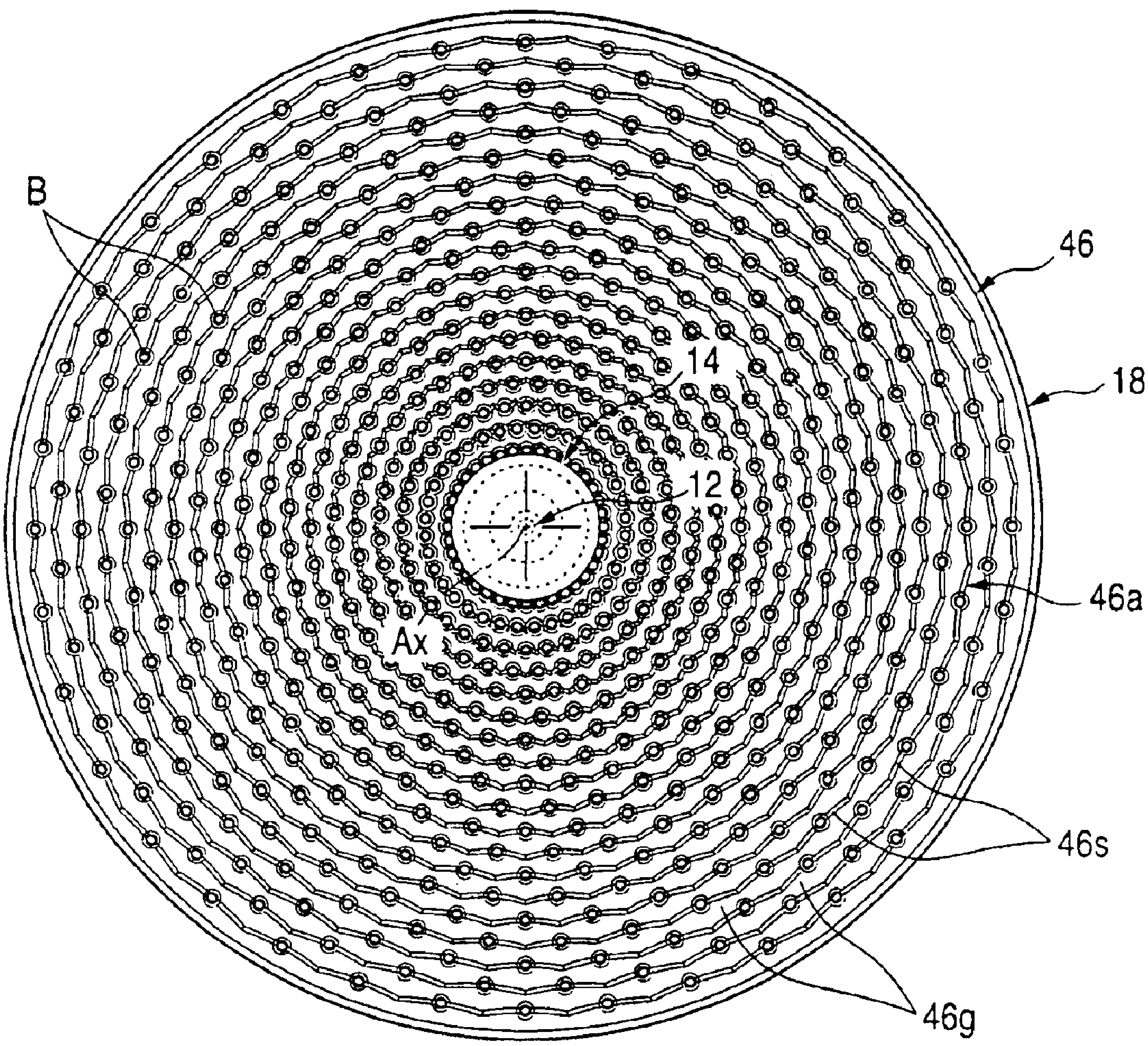


FIG. 12

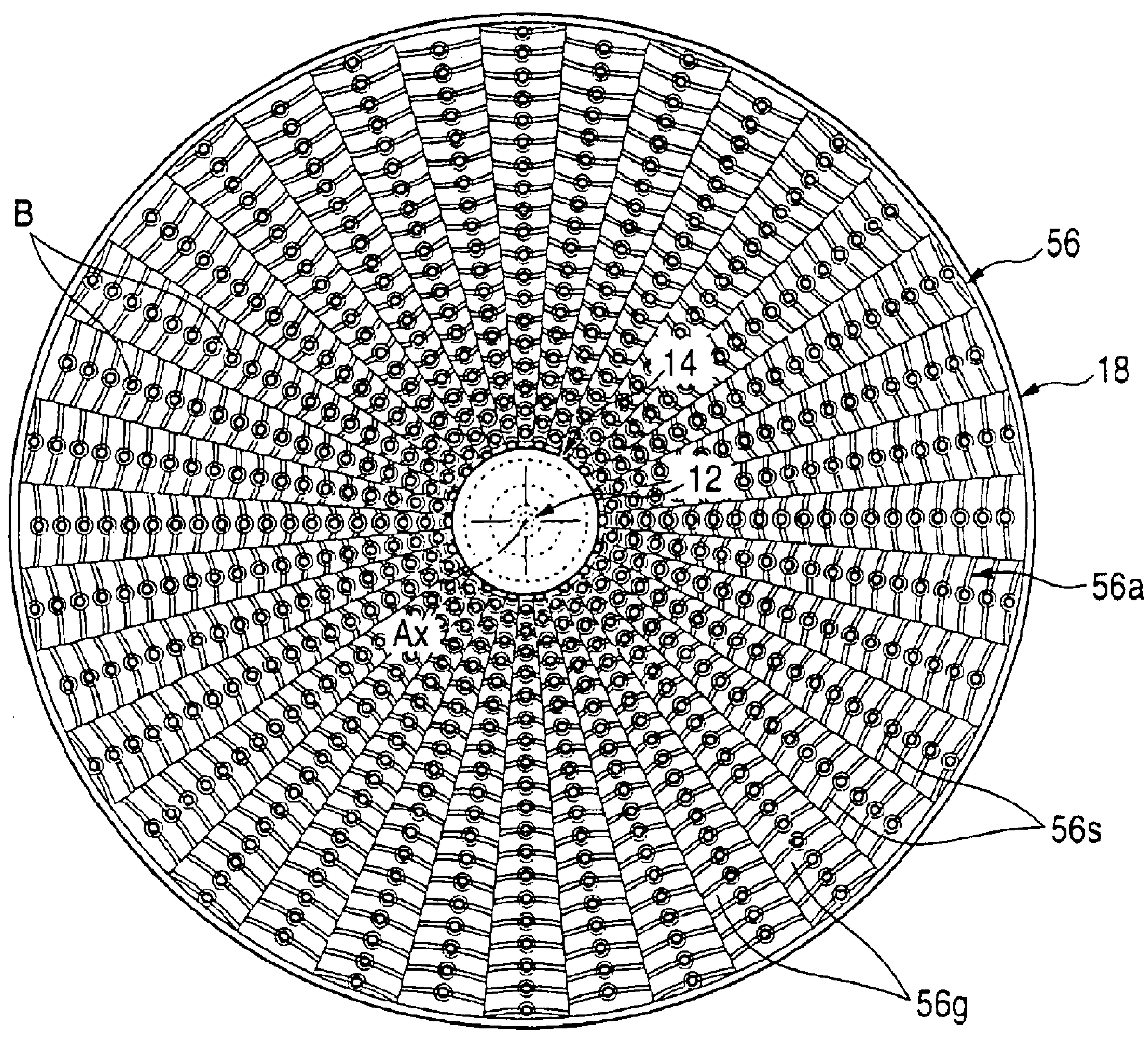
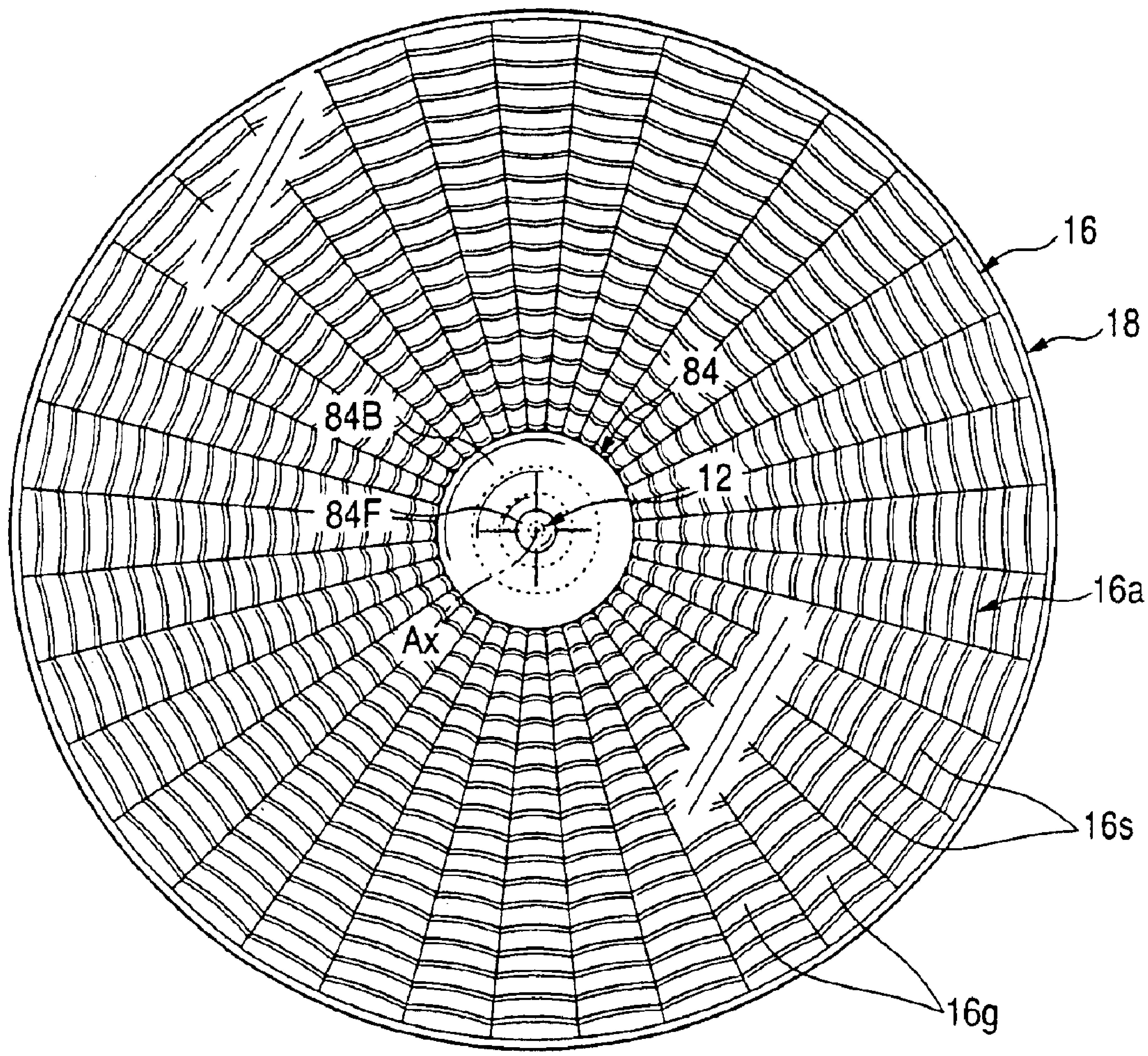


FIG. 13



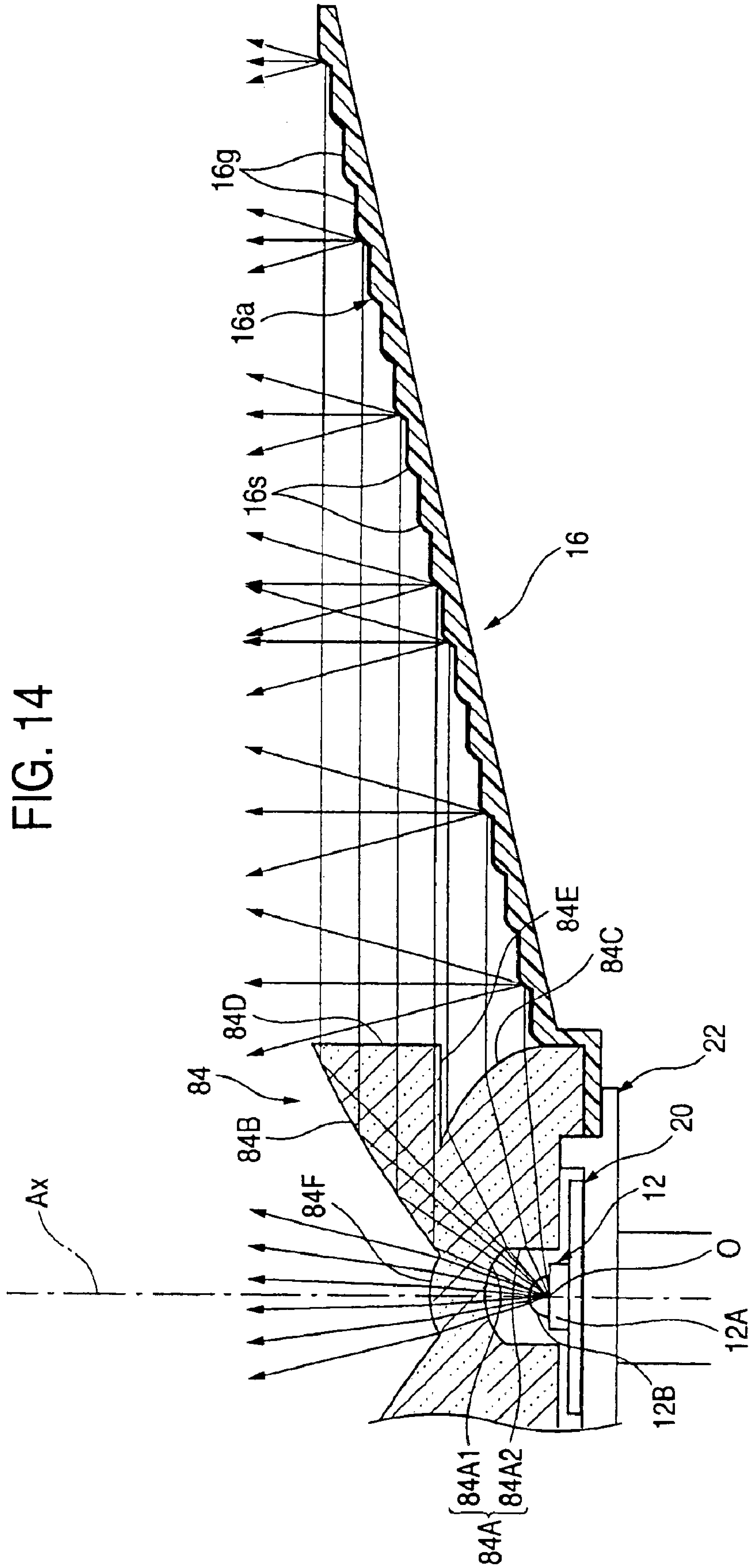

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FIG. 14

FIG. 15

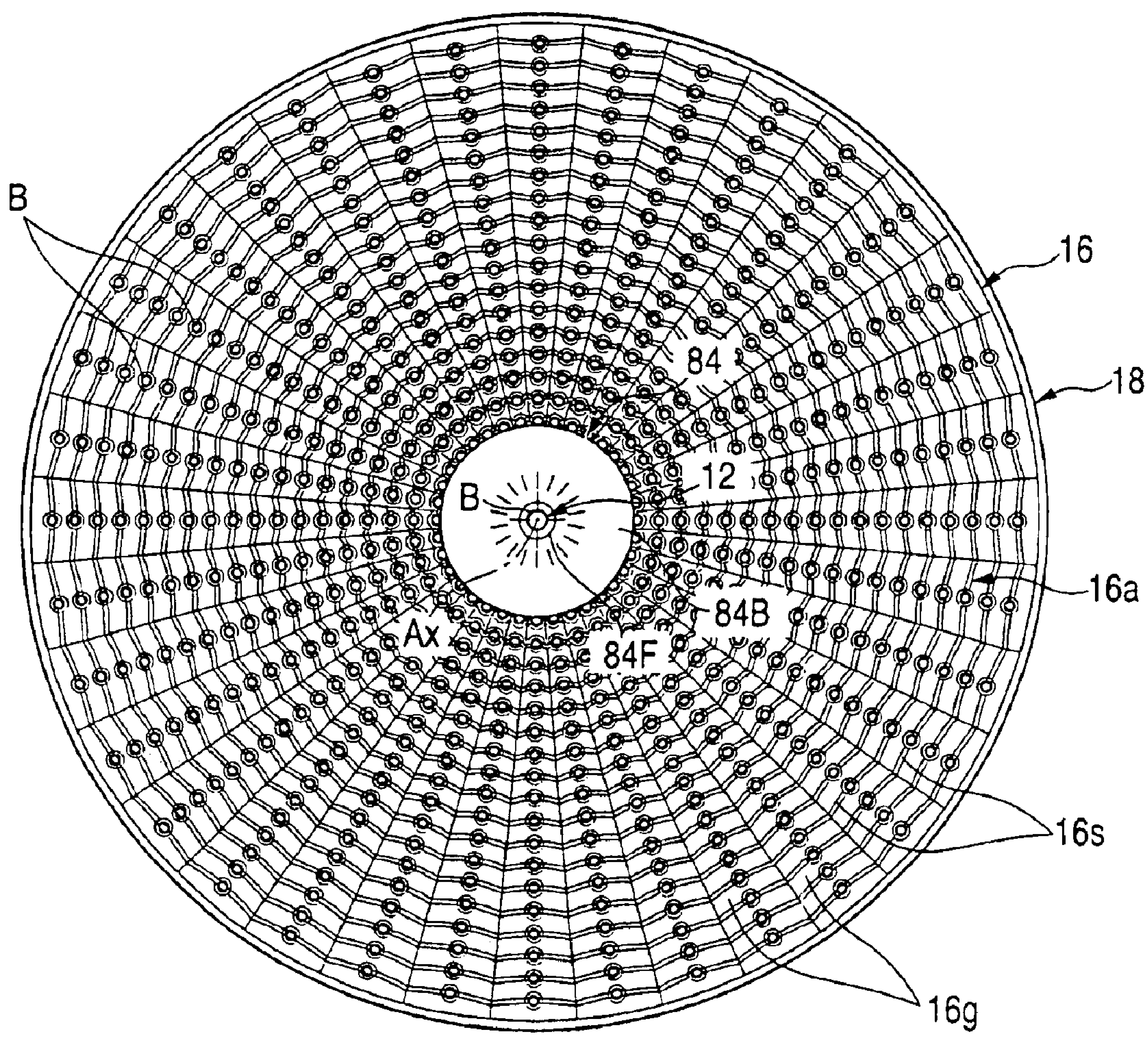
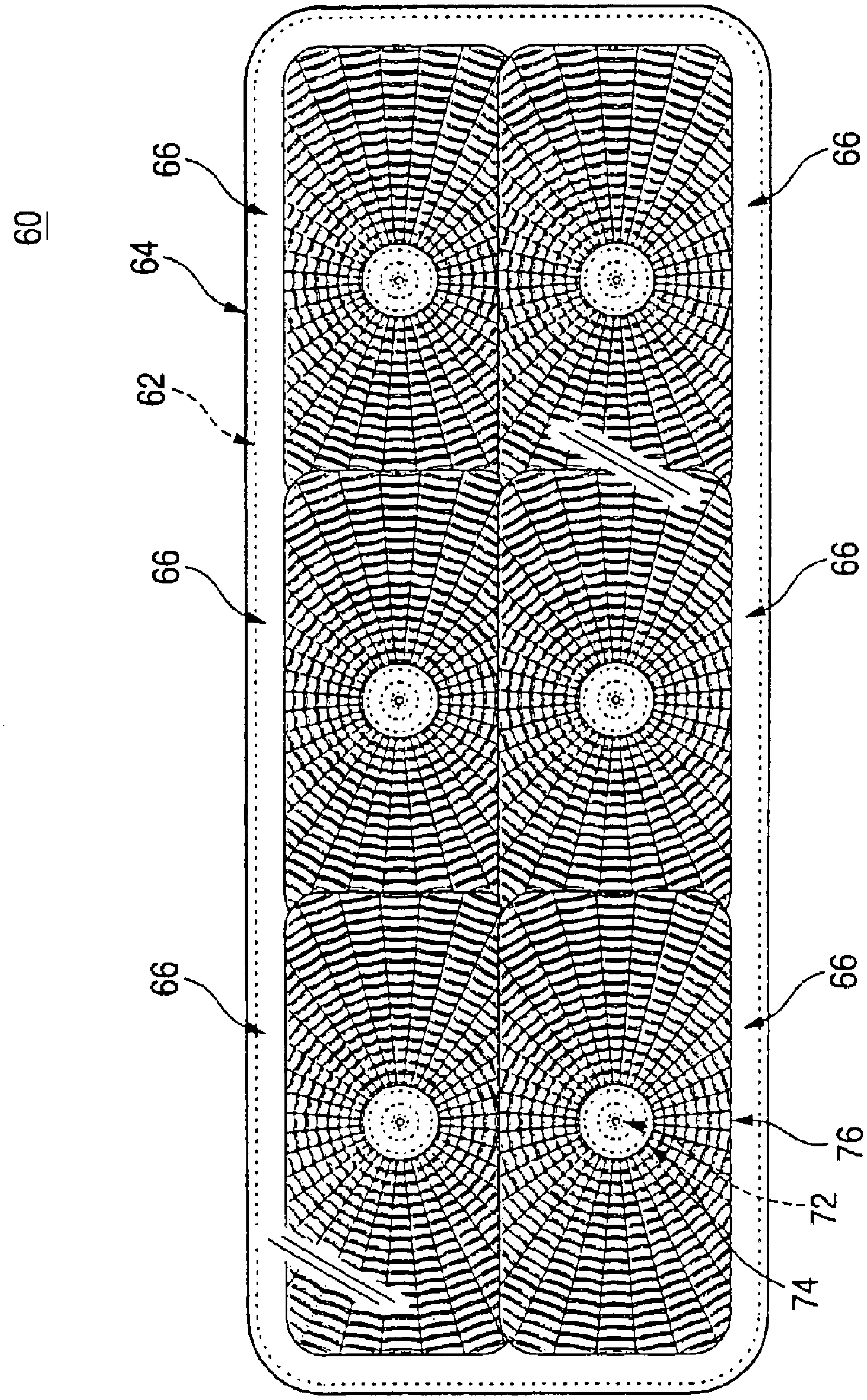


FIG. 16



VEHICLE LAMP

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a vehicle lamp comprising an LED (Light Emitting Diode) light source. More particularly, the present invention related to a vehicle lamp which comprises an LED light source in which a whole reflective surface of a reflector of the lamp can be seen glaring while the reflector size is reduced.

2. Description of the Related Art

Recently, vehicle lamps comprising an LED light source have been widely used. JP-UM-A-61-153201 discloses a vehicle lamp which is configured in the following manner. Light emitted from an LED light source, which is placed to be directed toward the front of the lamp, is incident on a translucent member. The light from the LED light source that is transmitted through the translucent member is reflected toward the front of the lamp by a reflector which is formed integrally with the translucent member.

When a lamp is configured as described above, the light from the LED light source can be used in the form of reflected light from the reflector.

In the vehicle lamp disclosed in the publication, the direction of the light incident on a reflective surface of the reflector is varied depending on portions of the reflective surface. Consequently, there arise problems in that it is difficult to form the reflective surface so that, when the reflector is observed from the front side of the lamp, the whole reflective surface is seen glaring, and also that, in order to realize such formation, the reflector must be large in depth to some extent.

The invention has been conducted in view of such circumstances. It is an object of the invention to provide a vehicle lamp which comprises an LED light source, and in which a whole reflective surface of a reflector can be seen glaring while the reflector size is reduced.

SUMMARY OF THE INVENTION

In the invention, a translucent member is formed so as to have a unique shape to attain the above objects.

The vehicle lamp of the invention comprises: a light source, and preferably an LED light source which is placed to be directed toward a front of the lamp; a translucent member which is placed to receive light from the LED light source; and a reflector which is placed to reflect the light from the LED light source that is transmitted through the translucent member, toward the front of the lamp, wherein

an internal reflection portion and a refraction portion are formed on a surface of the translucent member, the internal reflection portion internally reflecting small-angle incident light in a direction which is substantially perpendicular to an optical axis of the LED light source, the small-angle incident light being incident on the translucent member at a small angle with respect to the optical axis, the refraction portion retracting large-angle incident light in a direction which is substantially perpendicular to the optical axis, the large-angle incident light being incident on the translucent member at a large angle with respect to the optical axis.

The kind of vehicle lamp is not restricted to particular kinds of vehicle lamps, and may be employed as a tail lamp, a stop lamp, or the like.

The material of translucent member is not particularly restricted as long as the member is translucent. For example, a member made of a transparent synthetic resin or glass may be used as the translucent member. Also specific shapes of the internal reflection portion and the refraction portion of the translucent member are not particularly restricted.

For the reflector, the specific shape of the reflective surface and the like are not particularly restricted as far as the light from the LED light source that is transmitted through the translucent member can be reflected toward the front of the lamp. Moreover, the reflector may be a usual reflector which is configured so as to reflect the light from the LED light source by the outer surface, or a reflector which is made of a transparent member so as to internally reflect the light from the LED light source that is transmitted through the reflector. In the latter case, the reflector may be configured separately from the translucent member, or a part of the reflector may be configured integrally with the translucent member.

As described above, the vehicle lamp of the invention is configured so that the light from the LED light source which is placed to be directed toward the front of the lamp is incident on the translucent member, and the light from the LED light source that is transmitted through the translucent member is reflected by the reflector toward the front of the lamp. The internal reflection portion that internally reflects small-angle incident light which is incident on the translucent member at a small angle with respect to the optical axis of the LED light source, in a direction which is substantially perpendicular to the optical axis, and the refraction portion that refracts a large-angle incident light which is incident on the translucent member at a large angle with respect to the optical axis, in a direction which is substantially perpendicular to the optical axis are formed on the surface of the translucent member. Therefore, the light from the LED light source can be caused to be incident on the reflective surface of the reflector in the form of substantially parallel beams which are directed in a direction that is substantially perpendicular to the optical axis.

Consequently, the light from the LED light source can be caused to be incident on the range extending even to the peripheral edge of the reflective surface, without increasing the depth of the reflector. Since the light from the LED light source is incident in the form of substantially parallel beams on the reflective surface of the reflector, the reflection due to the reflector can be easily controlled.

According to the invention, in the vehicle lamp comprising the LED light source, therefore, the whole reflective surface can be seen glaring while the reflector size can be reduced.

In the above configuration, the internal reflection portion of the translucent member may be configured by a generally funnel-like curved surface of revolution about the optical axis, and the refraction portion of the translucent member may be configured by a generally annular dome-like curved surface of revolution about the optical axis. According to the configuration, it is possible to attain the following functions and effects.

Namely, the light from the LED light source can be caused to be incident on the reflective surface of the reflector over the whole periphery of the optical axis, in the form of substantially parallel beams which are directed in a direction that is substantially perpendicular to the optical axis. Therefore, a large light emission area can be ensured by the single LED light source. Moreover, the LED light source can be placed at the center of the lamp, and hence the external shape of the lamp can be freely set.

In the above configuration, the reflective surface of the reflector may be configured by a plurality of reflective elements which reflect the light from the LED light source that is transmitted through the translucent member, toward the front of the lamp, and the reflective elements may be placed in a stepwise manner via stepped portions elongating in a direction which is substantially perpendicular to the optical axis. According to the configuration, the lamp can be further thinned (i.e., its size reduced), and the whole reflective surface of the reflector can be seen glaring in an approximately uniformly scattered manner. Each of reflective elements may have a surface configuration which simply reflects the light from the LED light source so as to be deflected toward the front of the lamp, or that which reflects the light from the LED light source so as to be deflected toward the front of the lamp and diffused.

In the above configuration, at least part of the reflective surface of the reflector may be configured to reflect the light from the LED light source that is transmitted through the translucent member, toward the front of the lamp by internal reflection. In this case, the size of the lamp can be further reduced by a degree corresponding to the thickness of the reflector.

The vehicle lamp of the invention may comprise only one set of the LED light source, the translucent member, and the reflector. Alternatively, the vehicle lamp may comprise a plurality of sets of the LED light source, the translucent member, and the reflector. In the latter case, the brightness of the vehicle lamp can be further enhanced. In the invention, the external shape of the lamp can be freely set. In this case, therefore, the sets of the LED light source, the translucent member, and the reflector can be freely arranged in accordance with the shape of the lamp or the like.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front view showing a vehicle lamp of an embodiment of the invention;

FIG. **2** is a section view taken along line II—II of FIG. **1**;

FIG. **3** is a detail view of main portions of FIG. **2**;

FIG. **4** is a front view showing the vehicle lamp in a light-on state;

FIG. **5** is a view similar to FIG. **3** showing a reflector in a first modification of the embodiment;

FIG. **6** is a view similar to FIG. **3** showing a reflector in a second modification of the embodiment;

FIG. **7** is a view similar to FIG. **3** showing a translucent member in a third modification of the embodiment;

FIG. **8** is a view similar to FIG. **3** showing a translucent member in a fourth modification of the embodiment;

FIG. **9** is a view similar to FIG. **3** showing a translucent member in a fifth modification of the embodiment;

FIG. **10** is a view similar to FIG. **3** showing a translucent member in a sixth modification of the embodiment;

FIG. **11** is a view similar to FIG. **4** showing a reflector in a seventh modification of the embodiment;

FIG. **12** is a view similar to FIG. **4** showing a reflector in an eighth modification of the embodiment;

FIG. **13** is a view similar to FIG. **1** showing a translucent member in a ninth modification of the embodiment;

FIG. **14** is a view similar to FIG. **3** showing a translucent member in a ninth modification;

FIG. **15** is a view similar to FIG. **4** showing a translucent member in a ninth modification; and

FIG. **16** is a front view of a vehicle lamp of a tenth modification of the embodiment.

DETAILED DESCRIPTION OF THE INVENTION

Hereinafter, an embodiment of the invention will be described with reference to the accompanying drawings.

FIG. **1** is a front view showing a vehicle lamp of the embodiment, FIG. **2** is a section view taken along line II—II of FIG. **1**, and FIG. **3** is a detail view of main portions of FIG. **2**.

As shown in the figures, the vehicle lamp **10** of the embodiment is a tail lamp which is to be mounted on a rear end of a vehicle, and comprises an LED light source **12**, a translucent member **14**, a reflector **16**, and a translucent cover **18**.

The LED light source **12** is placed to be directed toward the front of the lamp ("rear side" of the vehicle, the same shall apply hereinafter) so that the optical axis Ax coincides with the center axis of the lamp which elongates in the longitudinal direction of the vehicle. The LED light source **12** consists of an LED main unit (LED chip) **12**A, and a sealing resin **12**B which covers the luminescence center O of the LED main unit **12**A in a hemispherical manner. The LED light source is fixed to a substrate support member **22** via a substrate **20**.

The translucent member **14** is configured by a transparent synthetic resin molded piece which is placed so as to cover the LED light source **12** from the front side, and a rear face portion of the member is fixed to the substrate support member **22**.

A light-incidence recess **14**A on which light from the LED light source **12** (hereinafter, often referred to as "LED emitted light") is to be incident is formed in the rear face portion of the translucent member **14**. The light-incidence recess **14**A is configured by a spherical portion **14A1** which spherically surrounds the luminescence center O, and a cylindrical portion **14A2** which cylindrically surrounds the optical axis Ax. In the LED emitted light, light which is emitted at a small angle (specifically, an angle of, for example, about 40 deg. or smaller) with respect to the optical axis Ax is incident perpendicularly on the spherical portion **14A1**, and then straightly advances through the translucent member **14**. By contrast, light which is emitted at a large angle (specifically, an angle which is larger than, for example, about 40 deg.) with respect to the optical axis Ax is incident obliquely on the cylindrical portion **14A2**, and then advances through the translucent member **14** being refracted toward the outer periphery of the translucent member **14**.

An internal reflection portion **14**B and a refraction portion **14**C are formed on the surface of the translucent member **14**. The internal reflection portion internally reflects the small-angle incident light (the light incident on the spherical portion **14A1**) which is incident on the translucent member **14** at a small angle with respect to the optical axis Ax, in a direction which is substantially perpendicular to the optical axis Ax. The refraction portion refracts the large-angle incident light (the light incident on the cylindrical portion **14A2**) which is incident on the translucent member **14** at a large angle with respect to the optical axis Ax, in a direction which is substantially perpendicular to the optical axis Ax.

The internal reflection portion **14**B is configured by a generally funnel-like curved surface of revolution about the optical axis Ax, in the front face of the translucent member **14**. On the other hand, the refraction portion **14**C is configured by a generally annular dome-like curved surface of revolution about the optical axis Ax, on the rear side of the internal reflection portion **14**B.

The portion of the surface of the translucent member **14** which is on the side of the outer periphery of the internal reflection portion **14**B is formed as a cylindrical outer peripheral portion **14**D which is configured by a cylindrical face centered at the optical axis Ax. According to the configuration, the LED emitted light which is internally reflected by the internal reflection portion **14**B to be directed in a direction that is substantially perpendicular to the optical axis Ax is caused to straightly advance through the cylindrical outer peripheral portion **14**D to the outside of the translucent member **14**. A rear end portion of the cylindrical outer peripheral portion **14**D is formed as an annular flat portion **14**E configured by a plane which is perpendicular to the optical axis Ax, so that the LED emitted light which is internally reflected by the internal reflection portion **14**B, and that which is refracted by the refraction portion **14**C are not blocked by the annular flat portion **14**E.

The reflector **16** is placed so as to reflect the LED emitted light which is transmitted through the translucent member **14**, toward the front of the lamp. The reflector **16** is configured by applying a reflective surface treatment on the front face of a synthetic resin molded piece which is formed into a flat conical shape, and has a circular external shape in the front view of the lamp.

A reflective surface **16***a* of the reflector **16** is configured by a plurality of reflective elements **16***s* which reflect the LED emitted light that is transmitted through the translucent member **14**, toward the front of the lamp. The reflective elements **16***s* are arranged so as to partition the reflective surface **16***a* radially and concentrically. With respect to a radial direction, the reflective elements **16***s* are placed at regular intervals in a stepwise manner via stepped portions **16***g* elongating along a plane which is substantially perpendicular to the optical axis

Each of the reflective elements **16***s* is formed into a convex curved surface in which a conical surface having a center axis coinciding with the optical axis Ax, and an apex angle of 90 deg. is used as a reference plane, and which has a predetermined curvature in both radial and circumferential directions with respect to the optical axis Ax. Therefore, the reflective elements diffusively reflect the LED emitted light from the translucent member **14** in both radial and circumferential directions with respect to the optical axis Ax.

The translucent cover **18** is a plain cover which is configured by a transparent synthetic resin molded piece, and has a circular external shape in the front view of the lamp. An outer peripheral edge of the translucent cover **18** is fixed to the reflector **16**.

FIG. **4** is a front view showing the vehicle lamp **10** of the embodiment in a state where the LED light source **12** is lit up.

As shown in the figure, when the vehicle lamp **10** is observed from the front side, the plural reflective elements **16***s* constituting the reflective surface **16***a* of the reflector **16** are seen simultaneously glaring in a scattered manner. At this time, center portions of the reflective elements **16***s* can be seen glaring as brilliant portions B because, as described above, each of the reflective elements **16***s* is formed into a convex curved surface in which a conical surface having a center axis coinciding with the optical axis Ax, and an apex angle of 90 deg. is used as a reference plane, and the LED emitted light is incident on the reflective elements in the form of substantially parallel beams.

Even when the visual point is somewhat deviated from the front direction of the lamp, in each of the reflective elements **16***s,* a portion which is shifted from the center portion by a degree corresponding to the movement amount of the visual point is seen glaring as a brilliant portion B because the LED emitted light is incident on the reflective elements **16***s* in the form of substantially parallel beams.

As described above in detail, the vehicle lamp **10** of the embodiment is configured so that the light from the LED light source **12** which is placed to be directed toward the front of the lamp is incident on the translucent member **14**, and the LED emitted light that is transmitted through the translucent member **14** is reflected by the reflector **16** toward the front of the lamp. The internal reflection portion **14**B that internally reflects the small-angle incident light which is incident on the translucent member **14** at a small angle with respect to the optical axis Ax of the LED light source **12**, in a direction which is substantially perpendicular to the optical axis Ax, and the refraction portion **14**C that refracts the large-angle incident light which is incident on the translucent member **14** at a large angle with respect to the optical axis Ax, in a direction which is substantially perpendicular to the optical axis Ax are formed on the surface of the translucent member **14**. Therefore, the LED emitted light can be caused to be incident on the reflective surface **16***a* of the reflector **16** in the form of substantially parallel beams which are directed in a direction that is substantially perpendicular to the optical axis Ax.

Consequently, the LED emitted light can be caused to be incident on the range extending even to the peripheral edge of the reflective surface **16***a,* without increasing the depth of the reflector **16**. Since the LED emitted light is incident in the form of substantially parallel beams on the reflective surface **16***a* of the reflector **16**, the reflection due to the reflector **16** can be easily controlled.

According to the embodiment, therefore, the whole reflective surface **16***a* can be seen glaring while the reflector **16** can be made thinner or smaller in size.

In the embodiment, particularly, the internal reflection portion **14**B of the translucent member **14** is configured by the generally funnel-like curved surface of revolution about the optical axis Ax, and the refraction portion **14**C of the translucent member **14** is configured by the generally annular dome-like curved surface of revolution about the optical axis Ax. Therefore, it is possible to attain the following functions and effects.

The LED emitted light can be caused to be incident on the reflective surface **16***a* of the reflector **16** over the whole periphery of the optical axis Ax, in the form of substantially parallel beams which are directed in a direction that is substantially perpendicular to the optical axis Ax. Therefore, a large light emission area can be ensured by the single LED light source **12**. Moreover, the LED light source **12** can be placed at the center of the lamp, and hence the external shape of the lamp can be freely set.

In the embodiment, the reflective surface **16***a* of the reflector **16** is configured by the plural reflective elements **16***s* which reflect the LED emitted light that is transmitted through the translucent member **14**, toward the front of the lamp, and the reflective elements **16***s* are placed in a stepwise manner via the stepped portions **16***g* elongating in a direction which is substantially perpendicular to the optical axis Ax. Therefore, the lamp can be further thinned, and the whole reflective surface **16***a* of the reflector **16** can be seen glaring in an approximately uniformly scattered manner.

In the embodiment, each of the reflective elements **16***s* has a surface configuration which diffusively reflects the LED emitted light from the translucent member **14** in both radial and circumferential directions with respect to the optical axis Ax. Alternatively, each of the reflective elements **16***s* may have a surface configuration which simply reflects the LED emitted light from the translucent member **14** so as to be deflected toward the front of the lamp, and the translucent cover **18** or the like may be provided with a diffusing function.

Next, a first modification of the embodiment will be described.

FIG. **5** is a view similar to FIG. **3** showing a reflector **26** in the modification.

As shown in the figure, in the reflector **26**, an inner peripheral portion on which the LED emitted light from the refraction portion **14**C of the translucent member **14** is incident is configured as an ordinary reflector portion **26**A, and an outer peripheral portion on which the LED emitted light from the internal reflection portion **14**B of the translucent member **14** is incident is configured as an internal reflection reflector portion **26**B.

The ordinary reflector portion **26**A has the same configuration as that of the inner peripheral portion of the reflector **16** in the embodiment. Namely, a reflective surface **26**Aa of the reflector **26** is configured by a plurality of reflective elements **26**As which are placed at regular intervals in a stepwise manner via stepped portions **26**Ag.

By contrast, the internal reflection reflector portion **26**B is configured to internally reflect the LED emitted light that is transmitted through the translucent member **14**, toward the front of the lamp by internal reflection. Specifically, the internal reflection reflector portion **26**B is formed integrally with the translucent member **14** by extending the translucent member **14** from the cylindrical outer peripheral portion **14**D (see FIG. **3**) in the outer peripheral direction. A reflective surface **26**Ba is formed on the outer peripheral end face of the reflector portion. The reflective surface **26**Ba is configured by a plurality of reflective elements **26**Bs which are placed at regular intervals in a stepwise manner via stepped portions **26**Bg.

Also when the configuration of the modification is employed, in the same manner as the embodiment, the whole reflective surfaces **26**Aa and **26**Ba can be seen glaring while the reflector **26** can be thinned.

When the configuration of the modification is employed, moreover, the internal reflection reflector portion **26**B is thinner than the outer peripheral portion of the reflector **16** in the embodiment on which the LED emitted light from the internal reflection portion **14**B of the translucent member **14** is incident, by a degree corresponding to the thickness of the reflector **16**. Therefore, the lamp can be compactly configured.

In the modification, the internal reflection reflector portion **26**B is configured by the transparent member. Therefore, a sense of transparency (sometimes known as a sense of crystal) can be produced particularly in the appearance when the LED light source **12** is turned off.

Next, a second modification of the embodiment will be described.

FIG. **6** is a view similar to FIG. **3** showing a reflector **36** in the modification.

As shown in the figure, in the reflector **36**, an outer peripheral portion on which the LED emitted light from the internal reflection portion **14**B of the translucent member **14** is incident is configured as an internal reflection reflector portion **36**B which is similar to the internal reflection reflector portion **26**B of the reflector **26** in the first modification. Namely, a reflective surface **36**Ba of the internal reflection reflector portion **36**B is configured by a plurality of reflective elements **36**Bs which are placed at regular intervals in a stepwise manner via stepped portions **36**Bg.

By contrast, in the reflector **36** in the modification, an inner peripheral portion on which the LED emitted light from the refraction portion **14**C of the translucent member **14** is incident is configured as an internal reflection reflector portion **36**A. The internal reflection reflector portion **36**A is configured by a transparent synthetic resin molded piece which is different from the translucent member **14**. A reflective surface **36**Aa of the reflector portion is configured by a plurality of reflective elements **36**As which are placed at regular intervals in a stepwise manner via stepped portions **36**Ag.

Also when the configuration of the modification is employed, in the same manner as the embodiment, the whole reflective surfaces **36**Aa and **36**Ba can be seen glaring while the reflector **36** can be thinned.

When the configuration of the modification is employed, moreover, the reflector **36** is thinner than the reflector **16** in the embodiment by a degree corresponding to the thickness of the reflector **16**. Therefore, the lamp can be more compactly configured.

In the modification, the whole reflector **36** is configured by the transparent member. Therefore, a higher sense of transparency (a sense of crystal) can be produced particularly in the appearance when the LED light source **12** is turned off.

Next, a third modification of the embodiment will be described.

FIG. **7** is a view similar to FIG. **3** showing a translucent member **24** in the modification.

As shown in the figure, in the translucent member **24**, a light-incidence recess **24**A is configured in a manner different from the light-incidence recess **14**A of the translucent member **14** in the FIG. **3** embodiment.

The light-incidence recess **24**A of the translucent member **24** is configured by a first spherical portion **24A1** which spherically surrounds the luminescence center O in a position close to the sealing resin **12**B of the LED light source **12**, and a second spherical portion **24A2** which is in the periphery of the first spherical portion **24A1**, and which spherically surrounds the luminescence center O by a radius that is larger than that of the first spherical portion **24A1**. In the LED emitted light, light which is emitted at a small angle with respect to the optical axis Ax is incident perpendicularly on the first spherical portion **24A1**, and then straightly advances through the translucent member **24**. Also light which is emitted at a large angle with respect to the optical axis Ax is incident perpendicularly on the second spherical portion **24A2**, and then straightly advances through the translucent member **24**.

In the same manner as the embodiment, an internal reflection portion **24**B, a refraction portion **24**C, a cylindrical outer peripheral portion **24**D, and an annular flat portion **24**E are formed on the surface of the translucent member **24**. Among the portions, the internal reflection portion **24**B, the cylindrical outer peripheral portion **24**D, and the annular flat portion **24**E are configured in strictly the same manner as those in the embodiment. By contrast, the refraction portion **24**C is formed so that the front end is positioned closer to the optical axis Ax than that of the refraction portion **14**C in the embodiment, in order to cause the LED emitted light which advances through the translucent member **24** straightly and radially from the luminescence center O, to be refracted in a direction which is substantially perpendicular to the optical axis Ax.

Also when the configuration of the modification is employed, in the same manner as the embodiment, the LED emitted light can be caused to be incident on the reflective surface **16***a* of the reflector **16** in the form of substantially parallel beams which are directed in a direction that is substantially perpendicular to the optical axis Ax.

When the configuration of the modification is employed, moreover, the LED emitted light advances through the translucent member **24** straightly and radially, and hence the optical computation for setting the curved shape of the refraction portion **24**C can be easily conducted.

Next, a fourth modification of the embodiment will be described.

FIG. **8** is a view similar to FIG. **3** showing a translucent member **34** in the modification.

As shown in the figure, in the translucent member **34**, a light-incidence recess **34**A is configured in a manner different from the light-incidence recess **14**A of the translucent member **14** in the FIG. **3** embodiment.

The light-incidence recess **34**A of the translucent member **34** is formed into a bottomed cylindrical shape. A gap between the light-incidence recess **34**A and the sealing resin **12**B of the LED light source **12** is filled with a transparent filler **40**. The filler **40** consists of a synthetic resin material which is approximately equal in refractive index to the translucent member **34**. In the translucent member **34**, the LED emitted light advances through the translucent member **34** straightly and radially from the luminescence center O via the filler **40**.

The translucent member **34** comprises an internal reflection portion **34**B, a refraction portion **34**C, a cylindrical outer peripheral portion **34**D, and an annular flat portion **34**E which are strictly identical in shape with the corresponding portions of the translucent member **24** in the third modification.

Also when the configuration of the modification is employed, it is possible to attain the same functions and effects as those of the third modification.

In the modification, since the gap between the light-incidence recess **34**A and the sealing resin **12**B of the LED light source **12** is filled with the filler **40** which is approximately equal in refractive index to the translucent member **34**, substantially no refraction occurs in the interface between the filler **40** and the translucent member **34**. Therefore, the shape of the light-incidence recess **34**A of the translucent member **34** can be arbitrarily set. Although the light-incidence recess **34**A in the modification is set to have a simple shape or a bottomed cylindrical shape, it is a matter of course that the recess can be set to have another shape.

Next, a fifth modification of the embodiment will be described.

FIG. **9** is a view similar to FIG. **3** showing a translucent member **44** in the modification.

As shown in the figure, in the translucent member **44**, a light-incidence recess **44**A is configured in a manner different from the light-incidence recess **14**A of the translucent member **14** in the FIG. **3** embodiment.

In the translucent member **44**, the light-incidence recess **44**A is formed so as to be in close contact with the sealing resin **12**B of the LED light source **12**. In the translucent member **44**, the LED emitted light advances through the translucent member **44** straightly and radially from the luminescence center O of the LED light source **12**.

The translucent member **44** comprises an internal reflection portion **44**B, a refraction portion **44**C, a cylindrical outer peripheral portion **44**D, and an annular flat portion **44**E which are strictly identical in shape with the corresponding portions of the translucent member **24** in the third modification.

Also when the configuration of the modification is employed, it is possible to attain the same functions and effects as those of the third modification.

In the modification, since the light-incidence recess **44**A of the translucent member **44** is formed so as to be in close contact with the sealing resin **12**B of the LED light source **12**, the translucent member **44** can be easily formed by the insert molding process or the like, and the positional accuracy of the translucent member **44** can be enhanced.

Next, a sixth modification of the embodiment will be described.

FIG. **10** is a view similar to FIG. **3** showing a translucent member **54** in the modification.

As shown in the figure, the translucent member **54** is formed so as to hermetically seal the LED main unit **12**A of the LED light source **12**, thereby enabling the member to exert also the function of the sealing resin **12**B (see FIG. **3**) of the LED light source **12**. Unlike the translucent member **14** of the embodiment, the light-incidence recess **14**A (see FIG. **3**) is not formed in the translucent member **54**. In the translucent member **54**, the LED emitted light advances through the translucent member **54** straightly and radially from the luminescence center O of the LED light source **12**.

The translucent member **54** comprises an internal reflection portion **54**B, a refraction portion **54**C, a cylindrical outer peripheral portion **54**D, and an annular flat portion **54**E which are strictly identical in shape with the corresponding portions of the translucent member **24** of the third modification.

Also when the configuration of the modification is employed, it is possible to attain the same functions and effects as those of the third modification.

In the modification, since the translucent member **54** is formed so as to hermetically seal the LED main unit **12**A of the LED light source **12**, the number of parts can be reduced, and the positional accuracy of the translucent member **54** can be enhanced.

Next, seventh and eighth modifications of the embodiment will be described.

FIGS. **11** and **12** are views similar to FIG. **4** showing respectively reflectors **46** and **56** in the modifications.

As shown in the figures, in the reflectors **46** and **56** in the modifications, plural reflective elements **46***s* and **56***s* formed on reflective surfaces **46***a* and **56***a* are arranged in a manner different from those of the reflector **16** in the embodiment.

In the reflectors **46** and **56**, in the same manner as the reflector **16** in the embodiment, the reflective surfaces **46***a* and **56***a* are partitioned radially and concentrically, and the reflective elements **46***s* and **56***s*, and stepped portions **46***g* and **56***g* are allocated to the partitions. In the seventh modification, the positions of the reflective elements **46***s* are shifted from each other by a half pitch in a circumferential direction at every other pitch in a radial direction. By contrast, in the eighth modification, the positions of the reflective elements **56***s* are shifted from each other by a half pitch in a radial direction at every other pitch in a circumferential direction.

In the same manner as the reflective elements in the embodiment, the reflective elements **46***s* and **56***s* are formed into a convex curved surface which has a predetermined curvature in both radial and circumferential directions with respect to the optical axis Ax.

When the reflectors **46** and **56** are observed from the front side in a state where the LED light source **12** lights up, substantially center portions of the reflective elements **46***s* and **56***s* constituting the reflective surfaces **46***a* and **56***a* can be seen glaring as brilliant portions B. Since the reflective elements **46***s* and **56***s* are arranged in a manner different from those in the embodiment, the modifications can realize visual impressions different from the embodiment.

Next, a ninth modification of the embodiment will be described.

FIG. **13** and FIG. **14** show a translucent member **84** which is similar to the embodiment shown in FIG. **1** and FIG. **3**.

However, this embodiment is distinguishable from the translucent member **14** shown in FIGS. **1** and **3** in that a direct irradiation portion **84**F is formed on the translucent member **84**.

The direct irradiation portion **84** is formed in a small radius region with its center axis being defined by a light axis Ax so that the incident light at the vicinity thereof, which is part of the light having small incident angle toward the direct irradiation portion **84**, can be forwardly transmitted. As to the formation thereof, it is spherically formed of which curvature is set to be substantially the same as that of the spherical portion **84**A1 of the light-incident recess **84**A. Having such a translucent member **84**, the LED emitted light as scattered incident light toward the direct irradiation portion **84**F can be converged to the light axis side so as to be emitted in a certain diffusion angle. This diffusion angle might be set to be substantially the same as each reflective element **16**S.

As the result of the direct portion **84**F being formed, the size of the translucent member **84** might be larger as compared with that of other embodiment such as the translucent member **14**. Also, some minor change might be made to the shapes of the internal reflection portion **84**B and/or refraction portion **84**C, by which their functionality can be kept in proper way such that emitted LED light can be incident to the reflective surface **16***a* of the reflector **16** substantially as parallel light. As for the light-incident recess **84**A, and the cylindrical outer peripheral **84**D and the annular flat portion **84**E of the translucent member **84**, their structures are substantially the same as other embodiments.

FIG. **15** shows the front view of the vehicle headlamp of this embodiment in the state of emitting the light source **12**, which is provided with the translucent member **84**.

As shown in the drawing, when observation is made to the vehicle headlamp from the front direction, not only the reflective surface **16***a* but also the direct irradiation portion **84**F can be identified as brilliant part B. Further, the center portion of the direct irradiation part **84**F as well as each center portion of each reflective element **16**S can be simultaneously seen as scattering light points. The brilliant part B can be kept even in case of the observation point displaced a little from the center portions thereof in proportion to the mount of the displacement.

Next, a tenth modification of the embodiment will be described.

FIG. **16** is a front view of a vehicle lamp **60** of the tenth modification.

In the vehicle lamp **60**, plural (six) reflector units **66** are housed in a lamp housing configured by a lamp body **62** and a plain translucent cover **64**.

Each of the reflector units **66** comprises an LED light source **72**, a translucent member **74**, and a reflector **76**. The LED light source **72**, the translucent member **74**, and the reflector **76** are configured in the same manner as the LED light source **12**, the translucent member **14**, and the reflector **16** of the vehicle lamp **10** of the embodiment. However, the reflector **76** is set to have a laterally elongated rectangular external shape.

The reflector units **66** are arranged in two vertically juxtaposed horizontal rows so that outer peripheral edges of the reflectors **76** overlap with each other in the front view of the lamp.

When the configuration of the lamp of the modification is employed, it is possible to sufficiently ensure the brightness of the vehicle lamp **60**.

The reflectors **76** of the reflector units **66** may have an external shape other than the laterally elongated rectangular shape which is shown in the figure. Therefore, the reflector units **66** can be freely arranged in accordance with the shape of the lamp, etc.

Above, the embodiment and modifications in which the vehicle lamp **10** or **60** is a tail lamp have been described. Also in a case of a vehicle lamp of another kind (for example, a stop lamp, a tail & stop lamp, a clearance lamp, or a turn signal lamp), when the lamp is configured in a manner similar to the embodiment and modifications, it is possible to attain the same functions and effects as those of the embodiment and modifications.

What is claimed is:

1. A vehicle lamp comprising: a light source which is placed to be directed toward a front of the lamp; a translucent member which is placed to receive light from the light source; and a reflector which is placed to reflect the light from the LED light source that is transmitted through the translucent member, toward the front of the lamp, wherein

an internal reflection portion and a refraction portion are formed on a surface of the translucent member, the internal reflection portion internally reflecting small-angle incident light in a direction which is substantially perpendicular to an optical axis of the light source, the small-angle incident light being incident on the translucent member at a small angle with respect to the optical axis, the refraction portion refracting large-angle incident light in a direction which is substantially perpendicular to the optical axis, the large-angle incident light being incident on the translucent member at a large angle with respect to the optical axis; and

wherein a reflective surface of the reflector is configured by a plurality of reflective elements which reflect the light from the light source that is transmitted through the translucent member, toward the front of the lamp, and the reflective elements are placed in a stepwise manner via stepped portions elongating in a direction which is substantially perpendicular to the optical axis.

2. The vehicle lamp according to claim **1**, wherein the internal reflection portion is configured by a generally funnel-like curved surface of revolution about the optical axis, and the refraction portion is configured by a generally annular dome-like curved surface of revolution about the optical axis.

3. The vehicle lamp according to claim **1**, wherein at least part of a reflective surface of the reflector is configured to reflect the light from said LED light source that is transmitted through the translucent member, toward the front of the lamp by internal reflection.

4. The vehicle lamp according to claim **1**, wherein a direct irradiation portion by which said small-angle incident light being at the vicinity of the optical axis can be forwardly transmitted is provided on the translucent member.

5. The vehicle lamp according to claim **1**, wherein the vehicle lamp further comprises a plurality of sets of the light source, the translucent member, and the reflector.

6. The vehicle lamp according to claim **1**, wherein the light source is an LED light source.

7. The vehicle lamp according to claim **2**, wherein at least part of a reflective surface of the reflector is configured to reflect the light from said LED light source that is transmitted through the translucent member, toward the front of the lamp by internal reflection.

8. The vehicle lamp according to claim **7**, wherein a direct irradiation portion by which said small-angle incident light being at the vicinity of the optical axis can be forwardly transmitted is provided on the translucent member.

9. The vehicle lamp according to claim **8**, wherein the vehicle lamp further comprises a plurality of sets of the light source, the translucent member, and the reflector.

10. The vehicle lamp according to claim **9**, wherein the light source is an LED light source.

11. The vehicle lamp according to claim **2**, wherein a direct irradiation portion by which said small-angle incident light being at the vicinity of the optical axis can be forwardly transmitted is provided on the translucent member.

12. The vehicle lamp according to claim **11**, wherein the light source is an LED light source.

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